THURSDAY, JANUARY 22, 1885

HIGH-LEVEL METEOROLOGY

Bericht über die Errichtung der Meteorologischen Station auf dem Säntis und ihre Thätigkeit, September 1883 *to August* 1884. Erstattet von R. Billwiller. (Zurich, 1884.)

Journal of the Scottish Meteorological Society. Third Series, No. 1.

WE briefly noticed at the time (NATURE, vol. xxix. p. 413) M. Billwiller's first report on the Swiss high-level station on Säntis, in the Canton of Appenzell; and his second report has now come to hand, giving, along with a rapid history of the establishment of this first-class meteorological observatory and its equipment, an excellent *résumé* of two full years' observations, ending August 31, 1884. A comparison of the results with those obtained for Ben Nevis presents several points of considerable importance.

On Säntis, 8094 feet high, the mean annual atmospheric pressure is 22·237 inches, the highest monthly mean being 22·429 inches in August, and the lowest 21·993 inches in March. On Ben Nevis, 4406 feet high, the mean annual pressure is 25·257 inches, the highest mean being 25·400 inches in July, and the lowest 25·141 inches in January. The differences between the highest and lowest is thus 0·436 and 0·259 inch respectively. On Säntis the mean annual temperature is 28°·2, the highest monthly mean being 41°·4 in August, and the lowest 18°·0 in January. The annual mean for Ben Nevis is 30°·9, the highest monthly mean being 41°·3 in July, and the lowest 22°·0 in February. The lower mean temperature of Säntis is thus wholly due to its colder winters.

But the most marked difference in the climates of the two situations is revealed by the hygrometer. On Säntis the mean annual relative humidity for the two years is 84, the highest monthly mean being 93 in September 1882, and the lowest 71 in March 1884. On Ben Nevis, on the contrary, the lowest mean monthly humidity was 90 for May 1884, and the highest for January of the same year, when the mean dry bulb was 25°·50, and wet bulb 25°·47, showing an approximate humidity of 99. Indeed, so thick and continuous was the covering of mist, fog, and cloud in which Ben Nevis was wrapped during this month, that the difference between the mean coldest and warmest hour of the day in winter is only half a degree. We have drawn attention (vol. xxx. p. 336) to the sudden changes of humidity which characterise the climate of Ben Nevis in connection with anticyclonic movements, when the atmosphere passes rapidly from a state of the most complete saturation to a state of dryness greater than is ever reached at lower levels in this part of Europe, and that on such occasions the temperature rapidly rises, till sometimes it even rises higher than at Fort William, about 4400 feet lower down. Now M. Billwiller gives an extremely valuable column in one of the tables, showing the minimum relative humidity observed each month, from which we see that a humidity of 21 occurred in August 1883, and that on six of the other twenty-three months a humidity less than 30 was recorded. The importance of these observations from Ben Nevis and Säntis on the great movements of the atmosphere in cyclones and anticyclones, and on the Föhn and the various theories that have been suggested in explanation of its phenomena, need not here be insisted on.

On Säntis the annual rainfall, inclusive of melted snow, was 67·83 inches. The heaviest rainfall of any month was 15·12 inches in July 1883, and the lightest 0·71 inch in February of the same year. On the top of Ben Nevis, for the five months from June to October of 1882 and 1883, the mean rainfall was 44·35 inches; and on Säntis, for the same five months of 1883 and 1884, the rainfall was 43·95 inches—the summer rainfall of the two places being thus nearly the same. These amounts are very greatly in excess of what several theories of the distribution of the rainfall on the slopes and tops of mountains would lead us to expect. In discussions of this question it will be necessary to give more pointed attention than has yet been given to the great vertical movements in the atmosphere which are disclosed by the hygrometric observations of these high-level stations.

Of even greater interest are the hourly observations at the two observatories, especially those relating to atmospheric pressure and wind. At the two places the hourly curves of pressure for different seasons run closely parallel to each other. In June, when the more special features of the curves are most pronounced, they closely approximate to a single diurnal minimum and maximum. The minimum occurs from 5 to 6 a.m., and the maximum from 9 to 10 p.m., the daily range being 0·039 inch on Säntis, and 0·030 inch on Ben Nevis. Each curve shows an extremely shallow secondary minimum from 5 to 6 p.m. which, as compared with the secondary maximum immediately preceding indicates a fall not exceeding 0·003 inch.

This secondary maximum occurs at 3 p.m. on Säntis, and at 3.30 p.m. on Ben Nevis, and is the analogue of the morning maximum which occurs at lower levels in the same localities six hours earlier. On Mount Washington, United States, this maximum occurred in June 1873 at 8.30 a.m. at the base of the mountain, 2898 feet above sea-level, 10 a.m. at 4059 feet, 11 a.m. at 5533 feet, and at noon on the top of the mountain at a height of 6285 feet. On Ben Nevis, while pressure is steadily falling at the base of the mountain from 9 a.m. to 4 p.m., on the peak it continues steadily to rise; and the same phenomena doubtless obtain at Säntis.

At the same time the diurnal velocity of the wind on these peaks shows even a stronger contrast when compared with the diurnal velocity at lower levels. At low levels and on plateaux of considerable extent the velocity of the wind falls to the daily minimum early in the morning, and rises to the maximum at or immediately after noon, or about the time of strongest insolation. The following table, showing the diurnal variation in the wind's velocity on Ben Nevis, Säntis, and Mount Washington in summer, and on Ben Nevis in winter, presents for these elevated peaks curves precisely the reverse of the curves for velocity at lower levels. The figures express in percentages the excess or defect of each hour's velocity from the daily mean :—

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	Ben Nevis, June—Aug. 1884	Säntis, June—Aug. 1884	Mt. Washington, May—June, 1873	Ben Nevis, Dec.—Feb. 1883—84
1 a.m.	15	18	20	9
2 ,,	15	24	15	7
3 ,,	19	24	9	8
4 ,,	12	16	8	7
5 ,,	7	12	8	3
6 ,,	8	8	1	5
7 ,,	0	4	− 2	3
8 ,,	− 2	− 7	0	1
9 ,,	− 3	− 13	− 8	− 3
10 ,,	− 5	− 15	− 10	− 6
11 ,,	− 11	− 20	− 12	− 8
noon	15	− 18	− 19	− 7
1 p.m.	− 11	− 19	− 16	− 7
2 ,,	− 15	− 17	− 12	− 7
3 ,,	− 14	− 11	− 15	− 7
4 ,,	− 10	− 11	− 13	− 7
5 ,,	− 10	− 9	− 7	− 3
6 ,,	− 5	− 8	− 4	− 4
7 ,,	− 3	7	− 1	5
8 ,,	− 0	10	− 3	3
9 ,,	0	5	5	4
10 ,,	9	2	15	8
11 ,,	11	7	19	8
midnight	9	9	19	6

Hence the maximum occurs on these heights shortly after midnight, and the minimum shortly after noon. Now it will be seen that these diurnal maxima and minima occur nearer midnight and noon than do the phases of the other meteorological phenomena, thus suggesting a direct connection with solar and terrestrial radiation. It is singular that, while the diurnal period of strongest insolation determines the occurrence of the maximum velocity of the wind over extensive land surfaces, it determines the minimum velocity on peaks rising to a great height above the land surfaces surrounding them. Of special importance in its bearings on the question is the curve of diurnal variation on Ben Nevis for the three winter months of 1883-84, when the mean velocity of the wind was nearly double that of the summer months. In that season Ben Nevis was under a deep covering of snow, the sky clouded nearly the whole time, the air frequently darkened with dense drifting fogs, and the difference between the mean lowest and highest hourly temperature only half a degree. Notwithstanding the practical uniformity of temperature of the surface of the top of Ben Nevis during the twenty-four hours of the day, the curve of the diurnal variation in the wind's velocity was as clearly marked in winter as in summer, and the two curves were alike in showing the occurrence of the maximum shortly after midnight, and the minimum shortly after noon. We must therefore conclude that the peculiar type of the diurnal curves of wind velocity on these elevated peaks is altogether independent of the temperature of the surfaces over which the winds blow. The results point not obscurely to an investigation of the relations of the visible and invisible vapour of the atmosphere to solar and terrestrial radiation as an inquiry of first importance in meteorology.

OUR BOOK SHELF

Exercises in Electrical and Magnetic Measurement. By R. E. Day, M.A. New Edition. (London: Longmans, Green, and Co., 1884.)

MR. DAY has produced a new and considerably improved edition of a most useful and valuable little book. Every teacher of electricity whose work is not confined to the beggarly elements of mere phenomena will thank Mr. Day for the admirable selection of problems put together in this volume. Nothing could be a greater boon to the real student than the means thus afforded of testing his knowledge of the exact quantitative laws of the science. If it were not for the historic interest of that rather antiquated instrument the torsion balance—we should doubt the utility of giving so much attention to it. Although the more modern electrometers have entirely superseded the torsion balance as an instrument of research and of measurement, it has, nevertheless, become so prominently fixed—like some grand old fossil long ago extinct—amongst the characteristic forms of electrical instruments, that examiners still expect candidates for examination to know something about it. On the other hand, the space allotted to moments of torsion and inertia is all too brief, though admirably filled. We must, however, take exception to the practice apparently followed on p. 62, of expressing a moment of couple in *dynes*: it should surely be *dyne-centimetres.* The section on the chemical (or rather thermo-chemical) theory of electromotive force is excellent. The problems comprised under the heading Electromagnetic Measurement are admirable, though perhaps a little beyond most students.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Earthquakes and Terrestrial Magnetism

MR. W. H. PREECE having written to the Astronomer Royal to ask whether any disturbance of our magnets or our earth-current apparatus was experienced during the recent earthquake in Spain, it may be interesting to communicate also for the information of your readers the result of an examination of our photographic registers in consequence made, and especially in order that what has been remarked may, if possible, receive confirmation.

As respects magnetic movement, the magnets on Dec. 25 last and following days were generally quiet. But on looking more closely at the registers, attention was at once drawn to a small simultaneous disturbance of the declination and horizontal force magnets, occurring at 9h. 15m. on the evening of December 25. Both magnets were at this time set into slight vibration, the extent of vibration in the case of declination being about 2′ of arc, and in horizontal force equivalent to ·001 of the whole horizontal force nearly. The movements have not the character of magnetic movements, and, if in reality produced by the earthquake, are of course simply an effect of the shock, the magnets being heavy bars suspended by silk threads some feet in length. About ten minutes afterwards there is doubtful indication in the horizontal force register of a second disturbance. There is no corresponding perceptible disturbance in the earth-current registers.

No other similar motion is observable either on December 25 or on the following days.

It may be remarked that in NATURE for January 1 last (p. 200) the time of occurrence of the earthquake at Madrid is said to be 8h. 53m. p.m. Taking this to be Madrid time, it corresponds to 9h. 8m. of Greenwich time. WILLIAM ELLIS

Royal Observatory, Greenwich, January 15

Teaching Chemistry

THE subject of science-teaching in schools, and more particularly the best way in which practical chemistry should be taught, has of late been discussed in the columns of NATURE. With the editor's leave, I should like to say a little regarding the methods of teaching chemical science in general.

NATURE for January 8 contained notes, by Profs. Sir H. E.

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